REMARKS

Rejections Under 35 USC §103

Claims 1-5, 12-20 and 42-43 have been rejected under 35 USC §103(a) as being unpatentable over DiLeo et al. (US Patent No. 4,209,358) in view of either Nishino et al. (US Patent No. 5,739,205) or Litke (US Patent No. 4,533,422).

Claims 1-5, 12-20 and 42-43 have been further rejected under 35 USC §103(a) as being unpatentable over DiLeo et al. in view of Mikuni et al. (US Patent No. 5,175,337), and further in view of either Nishino et al. (US Patent No. 5,739,205), or Litke (US Patent No. 4,533,422).

Claims 6-11, 42 and 44 have been rejected under 35 USC §103(as being unpatentable over Grigg et al. (US Patent No. 5,840,598) in view of Hiraiwa et al. (US Patent No. 4,980,086) and further in view of DiLeo et al. (US Patent No. 4,209,358), and Mikuni et al. (US Patent No. 5,175,337).

Claims 1-5, 12-20 and 42-43 have been rejected under 35 USC §103(a) as being unpatentable over DiLeo et al. (US Patent No. 4,209,358) in view of either Nishino et al. (US Patent No. 5,739,205) or Litke (US Patent No. 4,533,422) and further in view of O'Sullivan et al. (US Patent No. 3,832,334).

Claims 1-5, 12-20 and 42-43 have been further rejected under 35 USC §103(a) as being unpatentable over DiLeo et al. in view of Mikuni et al. (US Patent No. 5,175,337), and further in view of either Nishino et al. (US Patent No. 5,739,205), or Litke (US Patent No. 4,533,422) and further in view of O'Sullivan et al. (US Patent No. 3,832,334).

Claims 6-11, 42 and 44 have been rejected under 35 USC §103(as being unpatentable over Grigg et al. (US Patent No. 5,840,598) in view of Hiraiwa et al. (US Patent No. 4,980,086) and further in view of DiLeo et al. (US Patent No. 4,209,358), and Mikuni et al. (US Patent No.

5,175,337), and further in view of O'Sullivan et al. (US Patent No. 3,832,334).

Claims 21-22, 40-42 and 44 have been rejected under 35 USC §103(a) as being unpatentable over Grigg et al. (US Patent No. 5,840,598) in view of Burnett et al. (US Patent No. 2,628,178), Gruber et al. (US Patent No. 3,987,019), DiLeo et al. (US Patent No. 4,209,358), and Lamanna et al. (US Patent No. 4,871,790).

The rejections under 35 USC §103 are traversed for the reasons to follow.

Summary of the Invention

Independent claim 1 is directed to a "method for packaging a semiconductor die". The method includes the steps of "providing a leadframe", and "providing a cyanoacrylate adhesive material formulated to cure in contact with the die in less than about 60 seconds in a temperature of about 20°C to 30°C and an ambient atmosphere". The method also includes the steps of "applying the adhesive material in viscous form to the leadframe or the die", "placing the die on the leadframe with the adhesive material in contact with the die", and "polymerizing from 90-100% of the adhesive material in the temperature and the ambient atmosphere in less than about 60 seconds to cure the adhesive layer and bond the die to the leadframe". Antecedent basis for the "viscous form" recitation is contained on page 3, line 5 of the specification.

Independent claim 6 is similar to claim 1, and states the leadframe comprises "a plurality of lead fingers". This type of leadframe (14A-Figure 5) is sometimes referred to as lead-on-chip leadframe. Claim 6 also recites the steps of "placing the die on the lead fingers with the adhesive material compressed between the die and the lead fingers", and "wire bonding the die to the lead fingers".

Independent claim 12 is similar to claim 6 and states that the adhesive material includes "a filler".

Independent claim 15 recites a formula for the adhesive material. Claim 15 also recites the step of providing a filler in the adhesive material selected to tailor a characteristic of the adhesive material, and the step of "wire bonding the die to the lead frame".

Independent claim 21 is similar to claim 1, but recites that the adhesive material comprises an "anaerobic acrylic". Independent claim 42 is similar to claim 15, but states that the adhesive material comprises either a "cyanoacrylate adhesive" or an "anaerobic acrylic".

35 USC §103 Rejections of claims 1-5, 12-20 and 42-43 over DiLeo et al. in view of Nishino et al. or Litke

Independent claims 1, 12, 14 and 42 have been amended to further distinguish the steps of the claimed method from the prior art. Specifically, the independent claims recite the step of "polymerizing from 90-100% of the adhesive material ... to cure the adhesive layer". Antecedent basis for the term "polymerizing" is provided on page 7, lines 9-10 of the specification. Antecedent basis for the term "from 90-100%" is provided on page 8, lines 3-5 of the specification.

It is submitted that the cited combination of references does not disclose the combination of steps recited in claims 1, 12, 14 and 42. Specifically, there is no disclosure in the references of the claimed combination of "applying" a cyanoacrylate adhesive to a leadframe or to a semiconductor die, "placing" the die on the leadframe with the cyanoacrylate adhesive therebetween, and "polymerizing from 90-100%" of the cyanoacrylate adhesive "at a temperature between 20°C to 30°C in less than 60 seconds".

DiLeo et al. has been cited as teaching bonding of a semiconductor device to a leadframe using a room temperature curing adhesive. In DiLeo et al. an epoxy adhesive 31 is used to bond LEDs 10 to cups 23 on a leadframe 20 (column 3, lines 23-25). The same epoxy adhesive 31 is also used to bond leads 24 to the LEDs 10, and to posts 21 on the leadframe 2 (column 3, lines 25-30). DiLeo et al. teaches at column 3, lines 35-36 that "epoxies that cure at room temperature have also been used". Most epoxies will cure at room temperature provided a long enough time period is provided. However, there is no suggestion in DiLeo et al. of using an instant curing cyanoacrylate adhesive in which 90-100% of the adhesive material is cured in less than 60 seconds. The present method provides a process advantage in that semiconductor dice can be packaged faster, without a long cure time during die bonding.

Nishino et al. and Litke have been cited as teaching the use of cyanoacrylate adhesives in a variety of applications, and the incorporation of a filler in a cyanoacrylate adhesive. However, neither Nishino et al. or Litke teach the use of a cyanoacrylate adhesive for bonding a semiconductor die to a leadframe. As DiLeo et al. also does not provide this teaching, the cited combination of references does not anticipate the claimed combination of steps.

The cited combination of references also does not disclose the combination of steps recited in independent claims 12 and 42 of "placing" the die on lead fingers of a lead frame, and "wire bonding" the die to the lead fingers. Further, the cited combination of references does not teach the feature added to claim 12 of providing "an electrically insulating filler configured to reduce cross talk between the lead fingers". Antecedent basis for this added

recitation is contained on page 5, lines 9-12 of the specification.

Applicant would further argue that one skilled in the art at the time of the invention would have no incentive to combine the references in the manner of the Office Action. In this regard, neither Nishino et al. or Litke suggest using a cyanoacrylate adhesive to bond a semiconductor die to a leadframe. Further, DiLeo et al. is more concerned with the electrical characteristics of the adhesive 31 (e.g., low contact resistance - column 2, lines 47-48), than it's curing characteristics. In this regard, DiLeo et al. teaches that heat curing at a "temperature of 175°C to 185°C for <u>18</u> minutes" is acceptable (column 3, lines 48-50). In view of these teachings one skilled in the art without the benefit of the present disclosure, would not likely substitute an instant curing cyanoacrylate adhesive, because neither temperature or time appear to be a factor in the DiLeo et al. packaging process.

Nishino et al. and Litke were cited as teaching the incorporation of a filler in a cyanoacrylate adhesive. However, DiLeo et al. specifically teaches away from fillers in the adhesive (column 2, line 39). One skilled in the art would thus have no motivation to combine either Nishino et al. or Litke with DiLeo et al.

With respect to the addition of O'Sullivan et al. to the 35 USC §103 rejections, this reference was cited as teaching that cyanoacrylate adhesives cure in less than 60 seconds. Admittedly, this is an inherent characteristic of cyanoacrylate adhesive. However, the present claims are method claims, and the application of the instant curing characteristics of cyanoacrylate adhesives to semiconductor packaging is the patentable distinction.

35 USC §103 Rejections of claims 1-5, 12-20 and 42-43 over DiLeo et al. in view of Mikuni et al. and further in view of Nishino et al. or Litke

As these 35 USC §103 rejections are basically the same as the previous rejections, the same arguments are repeated. Also with regard to these rejections, Mikuni et al. has been added for it's teaching of filled cyanoacrylate adhesive compositions and their room temperature, instant curing characteristics. Although, both cyanoacrylate adhesives and semiconductor packaging have been around since at least the 1970s, cyanoacrylate adhesives have not heretofore been employed in semiconductor packaging to attach dice to leadframes. Applicant submits that the long time period in which cyanoacrylate adhesives have not been used for semiconductor die attach, is indicative of the unobviousness of the presently claimed method.

As previously argued, Applicant further submits that one skilled in the art at the time of the invention would have no incentive to make the cited combination of references.

With respect to the addition of O'Sullivan et al. to the 35 USC §103 rejections, the previous arguments on O'Sullivan et al. are restated.

35 USC §103 Rejections of claims 6-11, 42 and 44 over Grigg et al. in view of Hiraiwa et al. and further in view of DiLeo et al. and Mikuni et al.

Grigg et al. was cited as teaching a semiconductor packaging technique in which "a semiconductor chip or element or device is bonded or adhered to a lead frame utilizing a room temperature curable adhesive." However, Applicant is unable to locate any teachings in Grigg et al. which indicate the adhesive is selected to also cure at room temperature. Rather, Grigg et al. teaches that the "adhesive is applied at room temperature" (column 2, lines 30-34) and is then "easily cured" (column 2, line 33).

Implying that curing takes place at room temperature as in the Office Action seems like an unfair distortion of the teachings of Grigg et al., which is aided by the benefit of the present disclosure.

Further, Grigg et al. does not suggest "polymerizing from 90-100%" of the cyanoacrylate adhesive at a temperature between 20°C to 30°C in less than 60 seconds. As with DiLeo et al., neither room temperature curing or a fast curing time, appear to be factors the method of Grigg et al. Rather, the main consideration is that the adhesive have "the requisite tackiness and compliancy to be suitable to secure a semiconductor device, and a lead frame at room temperature" (column 5, lines 15-17). The present method is an improvement over the Grigg et al. method because the adhesive can be both applied and cured at room temperature. Further the adhesive cures quickly such that the die attach process is faster.

Hiraiwa et al. was cited for teaching the incorporation of "an electro and/or heat conductive (e.g., metal (powder) filler in a cyanoacrylate (monomer) composition which finds utility as a (general purpose) instant curing adhesive". However, the present method uses a cyanoacrylate adhesive for a very specific purpose, which is not suggested by Hiraiwa et al. Further, even though filled adhesives are known in the art, their use with a cyanoacrylate adhesives in the present application is submitted to be unobvious.

With respect to the addition of O'Sullivan et al. to the 35 USC §103 rejections, the previous arguments on O'Sullivan et al. are restated.

<u>35 USC §103 Rejections of claims 21-22, 40-42 and 44 over Grigg et al. in view of Burnett et al. and further in view of Gruber et al. and DiLeo et al. and Lamanna et al.</u>

Independent claim 21 recites that the adhesive is an "anaerobic acrylic". Independent claim 42 recites that the adhesive is a "cyanoacrylate adhesive or an anaerobic acrylic".

With respect to Grigg et al., the same arguments as above are repeated. Specifically, Grigg et al. does not suggest "polymerizing from 90-100%" of a die attach adhesive at a temperature between 20°C to 30°C, in less than 60 seconds.

Burnett et al. was cited as disclosing that "anaerobic curing acrylate/acrylic monomers are known to (a) polymerize rapidly at room temperature (i.e., without heat); and (b) find utility as adhesives in the bonding of various (e.g., electrical) substrates". However, there is no disclosure in Burnett et al., or in the combination of Burnett et al. and Grigg et al., of using anaerobic acrylics to bond semiconductor dice to leadframes.

Gruber et al. and Lananna et al. were cited for their teachings of fillers in anaerobic and acrylate compositions. However, even though filled adhesives are known in the art, their use with anaerobic acrylics in the present semiconductor packaging method is submitted to be unobvious.

<u>Conclusion</u>

In view of the amendments and arguments, favorable consideration and allowance of claims 1-22, and 40-44 is requested. A Petition For Extension Of Time (60 day) is also being filed with this Amendment. Should any issues remain, the Examiner is asked to contact the undersigned by telephone.

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Respectfully submitted:

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March 10, 2003
Date of Signature

Stephen A. Gratton
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MARKED VERSION OF AMENDED CLAIMS SHOWING CHANGES

1. (six times amended) A method for packaging a semiconductor die [to form a semiconductor package] comprising:

providing a leadframe;

providing a cyanoacrylate adhesive material formulated to cure in contact with the die in less than about 60 seconds in a temperature of about 20°C to 30°C and an ambient atmosphere;

[providing a filler in the adhesive material selected to tailor a characteristic of the adhesive material in the package;]

applying the adhesive material <u>in viscous form</u> to the leadframe or to the die;

placing the die on the leadframe with the adhesive material in contact with the die and the leadframe to form an adhesive layer therebetween; and

[curing] <u>polymerizing from 90-100% of</u> the adhesive material in the temperature and the ambient atmosphere in less than about 60 seconds to <u>cure the adhesive layer and</u> bond the die to the leadframe.

4. (six times amended) The method of claim 1 wherein the leadframe comprises a lead-on-chip leadframe<u>.</u> [and the filler is selected to increase a dielectric strength of the adhesive material.]

5. (four times amended) The method of claim 1 <u>further comprising providing a filler in the adhesive material</u>.

[wherein the filler is selected to improve thermal conductivity, mechanical strength, electrical conductivity, dielectric strength, moisture resistivity, or thermostability of the adhesive material in the package.]

6. (eight times amended) A method for packaging a semiconductor die [to form a semiconductor package] comprising:

providing a leadframe comprising a plurality of lead fingers;

providing a cyanoacrylate adhesive material formulated to cure in contact with the die in less than about 60 seconds at a temperature of about 20°C to 30°C and in an ambient atmosphere<u>;</u>

[, the adhesive material comprising an electrically conductive filler;]

applying the adhesive material <u>in viscous form</u> to the lead fingers or to the die;

placing the die on the lead fingers with the adhesive material compressed between the die and the lead fingers to form an adhesive layer therebetween;

[curing] <u>polymerizing from 90% to 100% of</u> the adhesive material at the temperature and in the ambient atmosphere in less than about 60 seconds to <u>cure the adhesive layer and</u> bond the die to the lead fingers;

wire bonding the die to the lead fingers; and

encapsulating the die.

10. (four times amended) The method of claim 6 wherein <u>the adhesive material includes an</u> [the] electrically conductive filler [comprises] <u>comprising</u> a material selected from the group consisting of Ag, Ni and Fe.

12. (eight times amended) A method for packaging a semiconductor die [to form a semiconductor package,] comprising:

providing a leadframe comprising a plurality of lead fingers;

applying an adhesive material in viscous form on the lead fingers or on the die, the adhesive material comprising a cyanoacrylate adhesive formulated to cure in contact with the die in less than about 60 seconds at a temperature of about 20°C to 30°C and in an ambient atmosphere, and an electrically insulating filler configured to reduce cross talk between the lead fingers;

placing the die on the lead fingers with the adhesive material in contact with the die and the lead fingers to form an adhesive layer therebetween; and

[curing] polymerizing from 90-100% of the adhesive material at the temperature and in the ambient atmosphere in less than about 60 seconds to cure the adhesive layer and bond the die to the lead fingers.

15. (six times amended) A method for packaging a semiconductor die [to form a semiconductor package,] comprising:

providing a leadframe;

providing an adhesive material having the formula:

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        COOR
       /
CH2=C
       \
        CN
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wherein R is a hydrocarbon group, the adhesive material formulated to cure in less than about 60 seconds in contact with the die at a temperature of about 20°C to 30°C and in an ambient atmosphere;

providing a filler in the adhesive material selected to tailor a characteristic of the adhesive material; [in the package;]

applying the adhesive material in a viscous form to the leadframe or to the die;

[applying a catalyst to the leadframe or to the die;]

placing the die on the leadframe with the adhesive material compressed between the die and the leadframe to form an adhesive layer therebetween;

[curing the adhesive layer] polymerizing from 90-100% of the adhesive material at the temperature and in the ambient atmosphere in less than about 60 seconds [by interaction of the adhesive material with the catalyst] to cure the adhesive layer and bond the die to the leadframe;

wire bonding the die to the lead frame; and

encapsulating the die.

16. (four times amended) The method of claim 15 further comprising following the applying step, applying a catalyst to the leadframe or to the die.

[wherein the catalyst comprises a compound selected from the group consisting of water and acid.]

19. (four times amended) The method of claim 15 wherein the leadframe comprises a lead-on-chip leadframe comprising a plurality of lead fingers configured for wire bonding to the die and for supporting the die. [in the package.]

21. (eight times amended) A method for packaging a semiconductor die [to form a semiconductor package] comprising:

providing a leadframe;

providing an adhesive material comprising an anaerobic acrylic formulated to cure in contact with the die in less

than about 60 seconds at a temperature of about 20°C to 30°C and in an ambient atmosphere;

[providing a filler in the adhesive material comprising a material selected from the group consisting of Ag, Fe and Ni;]

applying the adhesive material in viscous form to the leadframe or to the die;

placing the die on the leadframe with the adhesive material compressed between the die and the leadframe to form an adhesive layer therebetween; and

[curing] polymerizing from 90-100% of the adhesive material at the temperature and in the ambient atmosphere in less than about 60 seconds to cure the adhesive layer and bond the die to the leadframe.

41. (thrice amended) The method of claim 21 wherein the leadframe comprises a lead-on-chip leadframe comprising a plurality of lead fingers configured for wire bonding to the die and for supporting the die.
[in the package.]

42. (seven times amended) A method for packaging a semiconductor die [to form a semiconductor package,] comprising:

providing a lead-on-chip leadframe comprising a plurality of lead fingers configured to support the die and comprising a plurality of bonding sites;

providing an adhesive material comprising a cyanoacrylate adhesive or an anaerobic acrylic formulated to cure in contact with the die in less than about 60 seconds at a temperature of about 20°C to 30°C and in an ambient atmosphere;

providing a filler in the adhesive material selected to tailor a characteristic of the adhesive material; [in the package;]

applying the adhesive material <u>in viscous form</u> to the die or to the leadframe;

placing the die on the leadframe with the adhesive material in contact with the die and the lead fingers to form an adhesive layer therebetween;

[curing] <u>polymerizing from 90-100% of</u> the adhesive material at the temperature and in the ambient atmosphere in less than about 60 seconds <u>to cure the adhesive layer and</u> bond the die to the lead fingers;

wire bonding the die to the bonding sites; and

encapsulating the die and at least portions of the lead fingers.